

REMARKS

Applicants acknowledge receipt of an Office Action dated July 2, 2002. In this response, Applicants have amended claims 1-4, 6-9, 12, 23 and 24 and added claim 37. Support for these amendments may be found in the Specification *inter alia* at paragraph 0056. Following entry of these amendments, claims 1-37 are pending in the application. Claims 14-22, 27-32, 34 and 36 have been withdrawn from consideration by the PTO as drawn to non-elected subject matter.

Reconsideration is respectfully requested in view of the foregoing amendments and the remarks which follow.

Specification

On page 2 of the Office Action, the PTO has objected to paragraph 0004, because this paragraph refers to U.S. Patent No. 478,258. In this response, Applicants have deleted the reference to U.S. Patent No. 478,258 because it was apparently listed in error.

In addition to the foregoing, Applicants have amended the Specification to correct various minor informalities. In response to the PTO's comments in the third full paragraph on page 3 of the Office Action regarding the use of the phrase "a nitrogen compound (nitride)," Applicants have amended the Specification throughout to use the term --nitride--, where appropriate, for clarity. In addition, the terms, "{1,1,0}" or "{1,1,1}", which represent crystallographic direction have been corrected to appear as "<110>" or "<111>", respectively.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the outstanding objection to the Specification.

Claim Rejections Under 35 U.S.C. §112, 2nd Paragraph

On page 3 of the Office Action, the PTO has rejected claims 1-13 and 24 under 35 U.S.C. 112, second paragraph, as allegedly being indefinite.

In the response, Applicants have amended claim 1. Claim 1 now recites:

Giant magnetostrictive material whose dimensions vary at the application of an external magnetic field thereon, comprising:

a mother alloy consisting essentially of a rare earth element and a transition element; and

nitrogen contained in the mother alloy;

wherein the nitrogen comprises an interstitial nitrogen interstitially dissolved in the mother alloy and a nitride-forming nitrogen in the mother alloy, a ratio of a content of the nitride-forming nitrogen to a total content of the nitrogen contained in the mother alloy being in the range of 0 to 0.05 by mass ratio.

Thus, "nitrogen contained in the mother alloy" is distinctly defined such that the nitrogen in the mother alloy comprises both an interstitial nitrogen and a nitride-forming nitrogen in the mother alloy.

As is clear from the specification and context of the present application, "nitrogen compound" refers to --nitride--. Accordingly, Applicants have amended the specification and claims, where necessary to replace the phrase "nitrogen compound" with the term "nitride".

Applicants have also amended claims 3 and 4 to distinctly claim the subject matter thereof.

In claim 7, Applicants have replaced the phrase, "film due to a" with the phrase -film prepared by a--.

Applicants have also amended claims 6, 8, 9, 12, 23, and 24 to correct various minor informalities.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the outstanding rejections under §112.

Rejections under 35 U.S.C. §103

In the Office Action, the PTO has rejected claims 1-13, 23-26, 33 and 35 under 35 U.S.C. 103(a) as allegedly being unpatentable over each of U.S. Patent 5,395,459 to Pinkerton *et al.* (hereafter "Pinkerton") or U.S. Patent 5,425,818 to Hirosawa *et al.* (hereafter "Hirosawa"). Applicants respectfully traverse this rejection for the reasons set forth below.

In the Office Action, the PTO has acknowledged that Pinkerton and Hirosawa do not disclose the presence of a nitride in their alloys and that neither reference teaches Applicants presently claimed proportions and processing conditions. In rejecting the claims, the PTO has alleged (i) that each of Pinkerton and Hirosawa teaches a rare earth - transition metal - nitrogen alloy having a composition that overlaps the alloy composition recited in the instant claims, (ii) that each of these alloys is made by a process that overlaps the instantly claimed process, and (iii) that, as a result, the alloys taught by the references would be expected to possess all the same properties as recited in the instant claims.

Applicants respectfully disagree. As discussed in more detail below, the presently claimed magnetostrictive materials have different properties in comparison to and are therefore distinct from the hard/permanent magnets of Pinkerton and Hirosawa.

Amended claim 1 relates to a giant magnetostrictive material whose dimensions vary at the application of an external magnetic field. A magnetostrictive material is a soft magnetic material which can be magnetized easily by a external magnetic field and can be easily demagnetized by removing the external magnetic field.

In contrast to the presently claimed magnetostrictive material, the magnetic material disclosed in both Pinkerton and Hirosawa is a hard magnetic material for a permanent magnet which, necessarily, is difficult to demagnetize. Pinkerton explicitly states that "[t]his invention relates to magnetically hard samarium-iron-nitrogen (Sm-Fe-N) compositions--" in the introductory section entitled, Field of the Invention (column 1, lines 8-10) (Emphasis Added). Similarly, Hirosawa states that "[t]he present invention relates to a rare earth-iron-nitrogen permanent magnet comprising a interstitially nitrogen compound having a Tb₂Zn₁₇ crystal structure" in the industrial field of the

invention (column 1, lines 8-10) (Emphasis Added). The magnetic material of each reference is a hard, permanently magnetic material and is therefore distinct from the presently claimed magnetostrictive material which is a soft magnetic material which can be easily demagnetized. Neither Pinkerton or Hirosawa make any disclosure of magnetostriction.

Further, neither of these references teach or fairly suggest that the ratio of nitride-forming nitrogen to the total nitrogen contained in the mother alloy should be in the range of 0 to 5% by mass, that is, a content of an interstitial nitrogen in the total nitrogen in the mother alloy is 95% or more by mass.

In the present invention, by suppressing the formation of nitride and dissolving most added nitrogen as an interstitial nitrogen in the lattice of the mother alloy, it is possible to obtain a magnetostrictive material having an enhanced Curie point while suppressing the decrease of magnetostriction and the deterioration of mechanical properties.

A giant magnetostrictive material of claim 1 of the present invention is a magnetic material whose dimensions vary at an application of an external magnetic field thereon, comprising: a mother alloy consisting essentially of a rare earth element and a transition element; and nitrogen contained in the mother alloy;

wherein the nitrogen comprises an interstitial nitrogen interstitially dissolved in the mother alloy and a nitride-forming nitrogen in the mother alloy, and a ratio of a content of the nitride-forming nitrogen to a total content of the nitrogen contained in the mother alloy is in the range of 0 to 0.05 by mass ratio.

As outlined *supra*, neither Pinkerton nor Hirosawa, taken either individually or in proper combination, teach or properly suggest a magnetostrictive material with the features of amended claim 1.

Claims 2-13, 23-26, 33 and 35 depend directly or indirectly from claim 1 and are believed allowable for the same reasons as claim 1.

With particular regard to claim 9, paragraph 0056 of the present Specification discloses that the mother alloy of the magnetostrictive material comprises a Laves

phase as a primary phase. A Laves phase is an alloy represented by RT_2 , wherein R is rare earth element and T is a transition metal element including Fe, Co, or Ni. As set forth in claim 9 of the present application, the mother alloy is expressed by the formula:



wherein A denotes at least one element selected from rare earth elements including Y, T denotes at least one element selected from Fe, Co and Ni, M denotes at least one element selected from transition elements other than the T elements, and X and Z are numbers satisfying $0.5 \leq X \leq 1$, $1.4 \leq Z \leq 2.5$. As disclosed on page 19, paragraph 0060 in the specification, a rare earth-transition metal alloy of the present invention has a composition substantially having an atomic ratio of rare earth element to transition metal 1:2, such as YFe₂, SmFe₂ and the like are (page 19, lines 3 to 7).

In contrast, Pinkerton discloses a composition of Sm_2Fe_{17} having a series of rhombohedral Tb_2Zn_{17} structure or a rare earth rich disordered hexagonal $SmFe_7$ having the $TbCu_7$ structure (column 6, lines 30 to 43). Further, with regard to $SmFe_2$, Pinkerton discloses that “[c]ubic $SmFe_2$ is present in the as-quenched ribbon as an impurity phase” (col. 6, 46-47), and further discloses that “[u]pon nitriding [t]he $SmFe_2$ peaks disappear” (lines 53 to 61). Hirosawa et al. also discloses a compound having a Th_2Zn_{17} crystal structure and comprising a composition $T_{100-x-y}R_xN_y$, wherein T is Fe or Fe containing Co or Cr, R is rare earth element including Sm, x is in the range of 9 to 12 and y is in the range of 10 to 16. Thus, the cited references fail, individually or in fair combination, to teach or properly suggest a magnetostrictive composition as claimed in claim 9.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the outstanding rejection under §103.

Newly Added Claims 37

In this response, Applicants have added claim 37. Neither Pinkerton nor Hirsosawa, taken individually or in fair combination, teach or properly suggest a magnetostrictive material “wherein the mother alloy comprises a Laves phase as a primary phase,” as recited in claim 37.

CONCLUSION

In view of the foregoing amendments and remarks, Applicants respectfully submit that all of the pending claims are now in condition for allowance. An early notice to this effect is earnestly solicited. If there are any questions regarding the application, the Examiner is invited to contact the undersigned at the number below.

Respectfully submitted,

Date 10/2/02

By P.D.S.

FOLEY & LARDNER
Customer Number: 22428



22428

PATENT TRADEMARK OFFICE

Telephone: (202) 672-5540
Facsimile: (202) 672-5399

Paul D. Strain
Agent for Applicant
Registration No. 47,369

MARKED UP VERSION SHOWING CHANGES MADE

Below are the marked up replacement paragraph(s):

Page 2, first full paragraph:

To such demands, rare earth-transition metal base magnetostrictive alloy drew attention, some of these being put into practical use (cf. Japanese Patent Publication (KOKOKU) No. Sho 61-33892, [U.S. Pat. No. 478,258 Specification] and so on). However, the existing rare earth-transition metal base magnetostrictive alloy is not sufficient in the temperature characteristics such as Curie temperature or the like. For instance, in rare earth-iron alloy, magnetostriction deteriorates in a low temperature region. Furthermore, rare earth-cobalt alloy is difficult to use under a high temperature environment.

Page 7, paragraph 1:

similarly with the existing powder metallurgy process, the magnetostrictive material deteriorates in characteristics. Furthermore, crystallographic direction of anisotropic magnetostrictive alloy cannot be sufficiently aligned, resulting in only [a cubic sintered body] an isotropic sintered body. This causes deterioration of magnetostriction. The quenching process of the molten alloy in Japanese Patent Publication (KOKAI) No. HEI 1-246342 is implemented with an intention to make grain diameter finer.

Page 9, paragraph 1:

alloy of which primary components are rare earth and transition elements, and nitrogen contained in the mother alloy. Here, the nitrogen is interstitially dissolved in the mother alloy, a content of [nitrogen compound] nitride in the mother alloy, as a ratio of a content of nitrogen contained in the [nitrogen compound] nitride to a total content of nitrogen in the mother alloy, being 0.05 or less by mass ratio.

Page 9, second full paragraph:

In the first giant magnetostrictive material of the present invention, the mode of the magnetostrictive alloy is not particularly restricted, but various kinds of alloy

materials for instance such as unidirectionally solidified material, single crystal, quenched molten metal, sintered body [due to] prepared by powder metallurgy, or isotropic cast material can be used. Furthermore, an alloy thin film due to thin film deposition may be used.

Page 10, first full paragraph:

In the method of manufacturing the first giant magnetostrictive material, further in the step of adding nitrogen, the nitrogen is controlled to be contained in the mother alloy in the range from 0.01 to 2.5% by mass, and a content of [**nitrogen compound**] **nitride** in the mother alloy, by a mass ratio of a content of nitrogen contained in the [**nitrogen compound**] **nitride** to a total content of nitrogen in the mother alloy, to be 0.05 or less.

Page 14, first full paragraph:

In the second giant magnetostrictive material, the melt quench flakes contain the columnar structure grains extending in a thickness direction, more specifically is preferable to contain the columnar structure grains of 70% or more by volume ratio. Furthermore, the crystallographic direction in the thickness direction of the columnar structure grains mainly constituting the melt quench flakes is preferable to be approximate {1,1,0} or {1,1,1}. As to the crystallographic direction of the columnar grain here, when the columnar structure grains grow in a direction of [{1,1,0} or {1,1,1}] <110> or <111>, such a direction of crystal growth needs only to be within .+-.45 degrees with respect to a thickness direction of the flake material. Furthermore, it is preferable to contain 75% or more by volume of the columnar structure grains satisfying such condition.

Page 19, last paragraph:

However, even if the nitrogen content is optimized, when much of the added nitrogen forms the [**nitrogen compounds**] **nitrides** such as rare earth nitride or iron nitride, in spite of an increase of the Curie temperature, there occur problems in not only magnetostriction but also in mechanical reliability. That is, when the temperature is too

high during the nitrogen addition, the [nitrogen compound] nitrid tends to form easily to cause a change in the crystal structure, resulting in deterioration

Page 20:

magnetostriction. Furthermore, an increase of the generated nitrogen compound or excessive nitridation causes an increase of internal strain, on the basis thereof the mechanical characteristics being adversely affected. In the worst case, self-breakdown may occur.

From the above, in the present giant magnetostrictive material, first an amount of the [nitrogen compound] nitride present in the magnetostrictive alloy, by a ratio (mass ratio) of a content of nitrogen contained in the [nitrogen compound] nitride to a total content of nitrogen in the alloy, is reduced to be 0.05 or less. That is, the content of the nitrogen contained in the nitrogen compound is made 5% or less by mass to the total content of nitrogen in the alloy. In other words, nitrogen of 95% or more by mass of the total content of nitrogen added to the magnetostrictive alloy is interstitially dissolved in the primary phase of the magnetostrictive alloy as nitrogen atom.

As mentioned in the above, by controlling the formation of the nitrogen compound and dissolving interstitially most of the added nitrogen in the primary phase, while suppressing the crystal structure useful for magnetostriction from breaking down and the mechanical characteristics from deteriorating accompanying the formation of the [nitrogen compound] nitride, an increase effect of the Curie temperature due to nitrogen addition can be effectively obtained.

That is, when the content of nitrogen contained in the [nitrogen compound] nitride exceeds 0.05 by a mass ratio with

Page 21, first paragraph:

respect to the total content of nitrogen in the alloy, based on the amount of formation of the [nitrogen compound] nitride, deterioration of magnetostriction or mechanical characteristics is caused. The amount of the generated [nitrogen compound] nitride is preferably controlled to be 0.03 or less by the mass ratio with respect to the total amount of nitrogen contained therein. As to the interstitial introduction of the nitrogen,

as explained below, it is effective to lower the temperature when adding nitrogen, specifically the nitrogen addition under a low temperature environment such as 600.degree. C. or less.

Page 22:

fusion-thermalconductivity method). A content of nitrogen dissolved interstitially in the rare earth-transition metal alloy (mother alloy) denotes a value obtained by averaging nitrogen concentrations (excluding the nitrogen content present as the nitride) [due to] measured by line profile analysis by means of EPMA (Electron Probe Microanalyzer). The nitrogen content contained in the [nitrogen compound] nitride in the alloy is a value obtained by subtracting the interstitial nitrogen content [due to] measured by EPMA (average value of the concentrations of nitrogen interstitially dissolved in the mother alloy) from the total nitrogen content [due to analysis] measured by LECO analyzer.

More specifically, by analyzing the nitrogen content of the giant magnetostrictive material [due to] using LECO method, the total nitrogen content in the giant magnetostrictive material can be obtained. Then, the nitrogen content in the giant magnetostrictive material is measured by the line profile analysis [due to] using EPMA. In measurements due to the EPMA line profile analysis, a total area thereof is the total nitrogen content in the giant magnetostrictive material. This corresponds to the measurement [due to] using the analysis by LECO analyzer. In the line profile analysis [due to] using the EPMA, when the nitrogen compound is present, a peak appears as a singular point. Accordingly, by subtracting an area of the singular point from the total area, a concentration of nitrogen dissolved as simple nitrogen in the mother alloy can be obtained as an average value. The value is assigned as the nitrogen content dissolved interstitially in the rare earth-transition metal alloy.

Page 23, first paragraph:

In the first giant magnetostrictive material of the present invention, the dispersion of the content of the interstitially dissolved nitrogen (the nitrogen concentration excluding the nitrogen content present as the nitride) is preferable to be within . +-.30% with respect to the value averaged over the entire alloy. The dispersion

of the dissolved nitrogen over the entire magnetostrictive material is obtained based on the results of the line profile analysis [du to] using the EPMA.

Page 26, first full paragraph:

In the present first giant magnetostrictive material, the nitrogen in the range where temperature characteristics and magnetostriction are compatible is interstitially dissolved between the crystal lattice, thereby the nitrogen content present as the [nitrogen compound] nitride being largely reduced. Accordingly, while maintaining excellent magnetostriction and mechanical reliability, even under an environment exceeding for instance 100° C., such magnetostriction can be fully exhibited.

Page 28, first and second paragraphs:

nitrogen, or by mechanical alloying in an atmosphere containing nitrogen. Anyway, it is important to implement the nitrogen addition treatment in a temperature region of 600° C. or less. By implementing the nitrogen addition treatment in such temperature region, [nitrogen compounds] nitrides such as rare earth nitride or iron nitride due to the added nitrogen can be prevented from occurring. In other words, the added nitrogen can be effectively introduced interstitially between the crystal lattice of the alloy. When the temperature during the nitrogen addition treatment exceeds 600° C., the [nitrogen compound] nitride is rapidly increased in its amount.

The process of nitrogen addition will be detailed. When applying heat treatment to add nitrogen, rare earth-transition metal base alloy materials prepared by the use of various methods are preferably heat treated in an atmosphere containing nitrogen in the range of temperature from 200 to 600° C. Appropriate heat treatment conditions differ [due to] in accordance with the kind of alloy, kind of gas and atmospheric condition such as partial pressure of gas. However, when heat treating at a temperature exceeding 600° C., the nitrogen compound is formed greatly.

Page 29, last paragraph:

When applying the mechanical alloying method as the nitrogen addition treatment, to the rare earth-transition metal base alloy materials prepared due to the aforementioned various methods, the mechanical alloying is implemented in an

atmosphere containing nitrogen at a temperature region less than 600° C.. In the mechanical alloying, due to rotation of hard spheres, metal powder is repeatedly milled and compressed as if kneading. At that time, the nitrogen can be included in the alloy. Even in such mechanical alloying process, by setting an atmospheric temperature at 600° C. or less, the [nitrogen compound] nitride can be largely suppressed from

Page 30, second full paragraph:

In the nitrogen addition process, when a portion of high nitrogen concentration is locally formed in the alloy, the [nitrogen compound] nitride may be formed, a change of crystal structure may be caused. Accordingly, in order to suppress nonuniformity of the nitrogen concentration from occurring, depending on the kind or state of the material to treat, kind of gas, pressure of gas, mixing ratio of gas and heat treatment temperature and time for nitrogen addition are preferable to be adjusted.

Page 32, last paragraph:

When using anisotropic giant magnetostrictive material is employed, it is preferable for the crystallographic direction to be oriented. More specifically, in the case of the unidirectionally solidified material being used, in grains of 80% by volume or more of entire material, the crystallographic direction in a direction of an applied magnetic field (direction of which magnetostriction is used) is preferable to orient within .+-45 degrees from [{1,1,1}] <111> or [{1,1,0}] <110>. In other words, in 80% by volume or more of grains of the entire material, [{1,1,1}] or [{1,1,0}] <111> or <110> direction thereof

Page 33, second full paragraph:

In the case of single crystal being used, the crystallographic orientation in a direction of applied magnetic field (direction of which magnetostriction is used) is preferable to be oriented within .+-45 degrees from [{1,1,1}] or [{1,1,0}] <111> or <110>. At that time, the range of angle is more preferable to be within .+-30 degrees, still more preferable to be within .+-15 degrees. Thereby, similarly with the unidirectionally solidified material, the magnetostriction of the giant magnetostrictive material can be exhibited.

Page 36:

in that state. In the drawing, an arrow mark is a grain growth direction of the melt quench flake material 1, by applying a magnetic field in this direction, large magnetostriction being obtained.

The crystallographic direction in a thickness direction of the columnar structure that mainly constitute the melt quench flake material 1 is preferable to be approximate $\{\{1,1,1\}\} \langle 111 \rangle$ or approximate $\{\{1,1,0\}\} \langle 110 \rangle$. These crystallographic directions are ones large in magnetostriction. As the crystallographic directions of the columnar structure deviate from $\{\{1,1,1\}\} \langle 111 \rangle$ or $\{\{1,1,0\}\} \langle 110 \rangle$, the magnetostriction in a direction to use decreases. The crystallographic direction of the columnar structure here, when the columnar structure grow in a direction of $\{\{1,1,1\}\} \langle 111 \rangle$ or $\{\{1,1,0\}\} \langle 110 \rangle$, needs only for such grain growth direction to be within +45 degrees with respect to the thickness direction of the flake material 1. The melt quench flake material 1 needs only to contain the columnar structure satisfying such conditions by 75% by volume or more.

The grain growth direction (for example, $\{\{1,1,0\}\} \langle 110 \rangle$ or $\{\{1,1,1\}\} \langle 111 \rangle$) of the aforementioned columnar structure is more preferable to be within .+-.30 degrees with respect to the thickness direction of the flake material 1, still more preferable to be within .+-.20 degrees. Furthermore, the volume ratio of the columnar structure satisfying the above crystallographic direction conditions is more preferable to be 80% or more by volume, still more preferable to be 85% or more, desirably to be 90% or more.

Page 48, line 1 and first full paragraph:

within \pm 30 degrees from $\{\{1,1,0\}\} \langle 110 \rangle$.

Nitrogen contents (total nitrogen content) of the respective alloy materials after the nitrogen addition treatment are measured by means of LECO analysis, measurements being 0.1% by mass, 1.0% by mass and 1.5% by mass, respectively. Contents of nitrogen (average value) dissolved interstitially in the respective alloy materials are measured by means of EPMA, being 0.099% by mass, 0.99% by mass

and 1.47% by mass, respectively. Furthermore, presence of nitride is checked [due to] by X-ray diffractometer to be found that in the test piece of which nitrogen content (total nitrogen content) is 1.5% by mass, nitride is confirmed to form. However, when, from a value that is obtained by subtracting the interstitially dissolved nitrogen content from the total nitrogen content, a ratio of the nitrogen content contained in the nitride to the total nitrogen content is calculated, it is found to be such slight value as 0.02.

Page 50, Table 1 Header:

| No. | Composition (atomic ratio) | Nitrogen content (% by mass) | Ratio of nitrogen in <u>[compound]</u> <u>nitride</u> | Magneto- striction | Curie temperature |
|-----|-------------------------------|------------------------------------|--|-----------------------|----------------------|
| | | | | | |

Page 88, Abstract:

Giant magnetostrictive material, with an alloy including a rare earth element and a transition metal element, is obtained by dissolving nitrogen interstitially in the alloy. Nitrogen is introduced in the alloy in the range from 0.01 to 2.5% by mass. Nitrogen introducing treatment is carried out at a temperature of 600.degree. C. or less. A content of [nitrogen compound] nitride present in magnetostrictive alloy, by a ratio of a content of nitrogen in the nitrogen compound to a total nitrogen content in the alloy, is reduced to be 0.05 or less by mass ratio. Almost all of the added nitrogen is interstitially dissolved between crystal lattice. In giant magnetostrictive material using melt quench flakes, the flakes are stacked in a thickness direction that is a direction of growth of columnar grain essentially constituting the flake material to integrate in this state.

Below are the marked up amended claim(s):

1. (Amended) Giant magnetostrictive material whose dimensions vary at an application of an external magnetic field thereon, comprising:

a mother alloy consisting essentially of a rare earth element and a transition element; and

nitrogen contained in the mother alloy;

wherein the nitrogen [is interstitially introduced] comprises an interstitial nitrogen interstitially dissolved in the mother alloy and a nitride-forming nitrogen in the mother alloy, [a content of a nitrogen compound (nitride) in the mother alloy, as] a ratio of a content of the nitride-forming nitrogen [contained in the nitrogen compound to] to a total [nitrogen] content of the nitrogen contained in the mother alloy [,] being in the range of 0 to 0.05 [or less] by mass ratio.

2. (Amended) The giant magnetostrictive material as set forth in claim 1:

wherein the total content of the nitrogen [is] contained in the mother alloy is in the range from 0.01 to 2.5% by mass.

3. (Amended) The giant magnetostrictive material as set forth in claim 1:

wherein a dispersion of values of the content of the interstitial nitrogen [introduced interstitially] in the mother alloy is, with respect to an average value of the content of the interstitial nitrogen, within ± 30%.

4. (Amended) The giant magnetostrictive material as set forth in claim 1:

wherein a lattice constant of a grain of the mother alloy [therein the nitrogen is introduced] with the interstitial nitrogen is [increased] larger than a lattice constant of a grain of the mother alloy without the interstitial nitrogen by 0.1 % or more [in comparison with that before the introduction of the nitrogen].

6. (Amended) The giant magnetostrictive material as set forth in claim 1:

wherein the giant magnetostrictive material comprises [cubic] isotropic cast material.

7. (Amended) The giant magnetostrictive material as set forth in claim 1:

wherein the giant magnetostrictive material comprises an alloy thin film
[du t] f rmed by a film deposition process.

8. (Amended) The giant magnetostrictive material as set forth in claim 5:

wherein, in 80% or more by volume of grains in the alloy, a crystallographic direction in a direction of an applied magnetic field is oriented within ± 45 degrees from a crystallographic direction of [{1,1,1} or {1,1,0}] <111> or <110>.

9. (Amended) The giant magnetostrictive material as set forth in claim 1:

wherein the mother alloy comprises a composition essentially expressed by a general formula:



[()in the formula, R denotes at least one [kind of] element selected from rare earth elements including Y, T denotes at least one [kind of] element selected from the group consisting of Fe, Co and Ni, M denotes at least one [kind of] element selected from transition elements other than the T elements, and X and Z are numbers satisfying $0.5 \leq X \leq 1$, $1.4 \leq Z \leq 2.5$ []].

12. (Amended) The giant magnetostrictive material as set forth in claim 1:

wherein the mother alloy comprises at least one [kind] selected from the group consisting of hydrogen, boron, carbon, phosphorus and silicon in the range from 0.0001 to 3% by mass.

23. (Amended) A method for manufacturing giant magnetostrictive material, comprising the steps of:

heat treating a mother alloy consisting essentially of a rare earth element and a transition metal element in an atmosphere of vacuum or an inert gas; and

introducing nitrogen interstitially between crystal lattice of the mother alloy to form an interstitial solid solution in a temperature range of 600°C or less.

24. (Amended) The method for manufacturing giant magnetostrictive material as set forth in claim 23:

wherein in the nitrogen introducing step [is controlled so that] the nitrogen is introduced such that a total content of nitrogen contained in the mother alloy is in the range from 0.01 to 2.5% by mass, and a ratio of a content of nitrogen forming a [nitrogen compound] nitride in the mother alloy[, by a mass ratio of a content of nitrogen contained in the nitrogen compoundn] to [a] the total nitrogen content of nitrogen in the mother alloy[,] is 0.05 or less by mass.